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FAUNISTIC NOTE

The fauna of Geometrid moths of the Natural Forest Reserve "Cobîleni" Republic of Moldova – Preliminary data

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Abstract

Cobîleni Natural Forest Reserve with a surface of 33.5 ha is situated near Lopatna village, Orhei district, on the right bank of the Dniester River. The aim of the study was to assess the geometrid moths (Lepidoptera, Geometridae) fauna from this reserve. The most part of entomological materials from Cobîleni Natural Forest Reserve discussed in this paper were collected at the light trap during vegetation period of 2018. In the paper the list of fifty-five geometrids species is given, also their geographical distribution, ecological and trophic structure. The geometridae species collected from this reserve belong to five subfamilies. Most of the captured specimens belong to the Ennominae subfamily with 36 species, as it is typical for mesophilous meadows, followed by Sterrhinae with nine species, then Larentiinae with eight, and finally Orthostixinae and Geometrinae with only one species each. In the result of establishing of taxonomic affiliation of the entomological material collected during 2018, a new geometrid species for the fauna of the Republic of Moldova was identified: *Cyclophora linearia*.

Keywords

Geometridae, new records, rare species, Natural Forest Reserve, Republic of Moldova.

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PENSOFT

Introduction

It is well known, that the forests around the world are regarded as the most species rich habitats, especially for arthropods (Stork et al. 1997), that's why, protecting these ecosystems worldwide it is a primary task for all of us. Forests cover approximately 45% of Europe continent surface, being one of the most important terrestrial ecosystems (FAO 2010). Most of forested areas have management plans and just 6% of these forests are protected (FAO 2020). Regarding the National Forest Land of the Republic of Moldova, that accounts for roughly 12.7% of country territory (MoldSilva.gov.md), majority of forestland being under the state property. Despite the fact that the country has a small territory (33,843 km^2) a surface of 61,236.6 ha from the National Forest Land are taken under protection (Stanciu 2013).

The territory of the Republic of Moldova is situated at the interference of tree biogeographical regions: Central European forests, Mediterranean forests and Eastern European steppe, with transition zone between European forests and steppe region of Asia. Due to this fact, we have various unique landscapes, natural monuments with international value, and places filled with the charm of nature. Parts of these territories with a high biodiversity for the Republic of Moldova have been taken under the State Protection, one of them being and the Cobîleni Natural Forest Reserve.

The present study provides the first report regarding the diversity of Geometridae moths (Lepidoptera) from the Cobîleni Natural Forest Reserve from the Republic of Moldova. From flora point of view, the Cobîleni Natural Forest Reserve is well studied, but regarding the fauna – this is poorly known.

Despite of small territory (33.5 ha), the Cobîleni Natural Forest Reserve includes landscapes of flooded meadows, mixed forests and limestone rocks. The rock forest, specific to the steep slopes of the Dniester valley, are dominated by *Quercus robur* and *Fraxinus excelsior* species.

The objectives of the present paper were to investigate and to reveal the species of the Geometridae group from this reserve, their ecology and biology, not only for the tree pests but for the rare and banal, too.

We chose this theme due to that fact that Geometridae group is poorly studied not only from this reserve, but in our country, too. The last papers regarding this insect group were intended for the study of two major entomological collections: the „Catalogue of the N. Zubowsky" (Derjanschi et al. 2016) and Ruscinski (Timuş et al. 2017) whose entomological materials were collected in the early 1900s. Also, some short information about the distribution area, host plants, and ecological preference are given in this paper. Another purpose of this study was to research the forest pests from this part of country. It is well known that we have several species from Geometridae that form an ecological group belong to the most important forest defoliators, herbs and shrubs that cause serious damages in the forests, orchards, parks, etc. of the Republic of Moldova (Bulgari et al. 2016; Derjanschi et al. 2012; Rodideal et al. 2015; Wahlberg et al. 2010).

Materials and methods

The study area. The study was conducted in the Cobîleni Natural Forest Reserve (47°30'50.94"N, 29°1'20.37"E) of the Republic of Moldova (fig. 1), which is taken under protection since 1998. The reserve belongs to the Forest District Susleni, of State Forestry Enterprise Orhei (which occupies an area of 23,822 ha) (Postolache and Lazu 2018). The Cobîleni Natural Forest Reserve is a natural forest area with a surface of 33.5 ha, situated near Lopatna village, Orhei district, on the bank of the Dniester River (fig. 2).

According to the geomorphological regionalization, the reserve is located on the west Dniester's hills and its terraces, at 250–300 m altitude, characterized by a vertical fragmentation. Flooded meadows, mixed forests and limestone rocks, specific to the steep slopes of the Dniester Valley, covered by *Quercus robur* and *Fraxinus excelsior*, represent the studied reserve (fig. 4).

The vegetation of steep section in the middle part of the reserve, exposed to the east, consist of *Stipa pulcherrima*, *Amygdalus nana*, *Rhamnus cathartica*, *Thalictrum minus*, *Silene fabaria* etc. (fig. 3). Begu and Begu 2005 and Postolache and Lazu 2018 cited several endangered species of Lepidoptera such as *Zerynthia polyxena* and vulnerable as *Euplagia quadripunctaria* from this area.

Sampling Method. The research was carried out during the vegetation period of 2018. The entomological material was collected from different habitats of the Cobîleni Natural Forest Reserve like forest, forest edge, meadows and calcareous canyons using

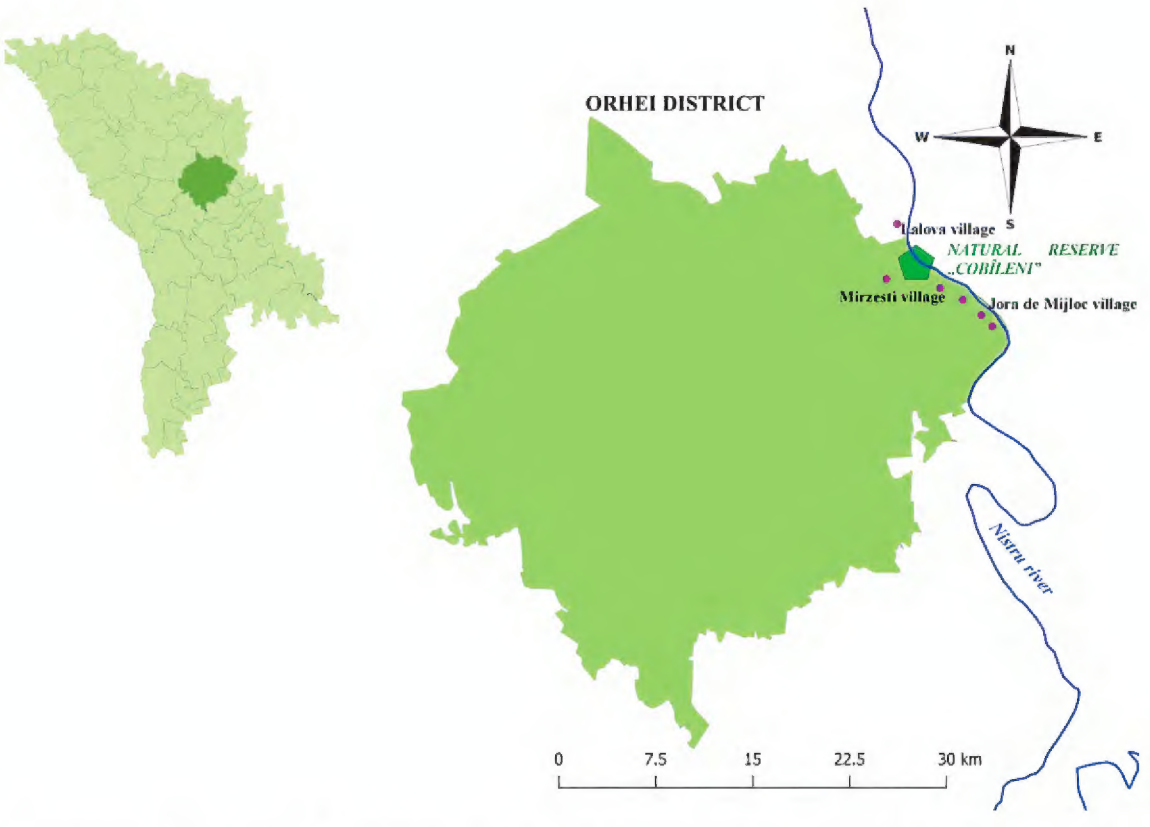

Figure 1. Location of the Cobîleni Natural Forest Reserve in the Orhei District of the Republic of Moldova.

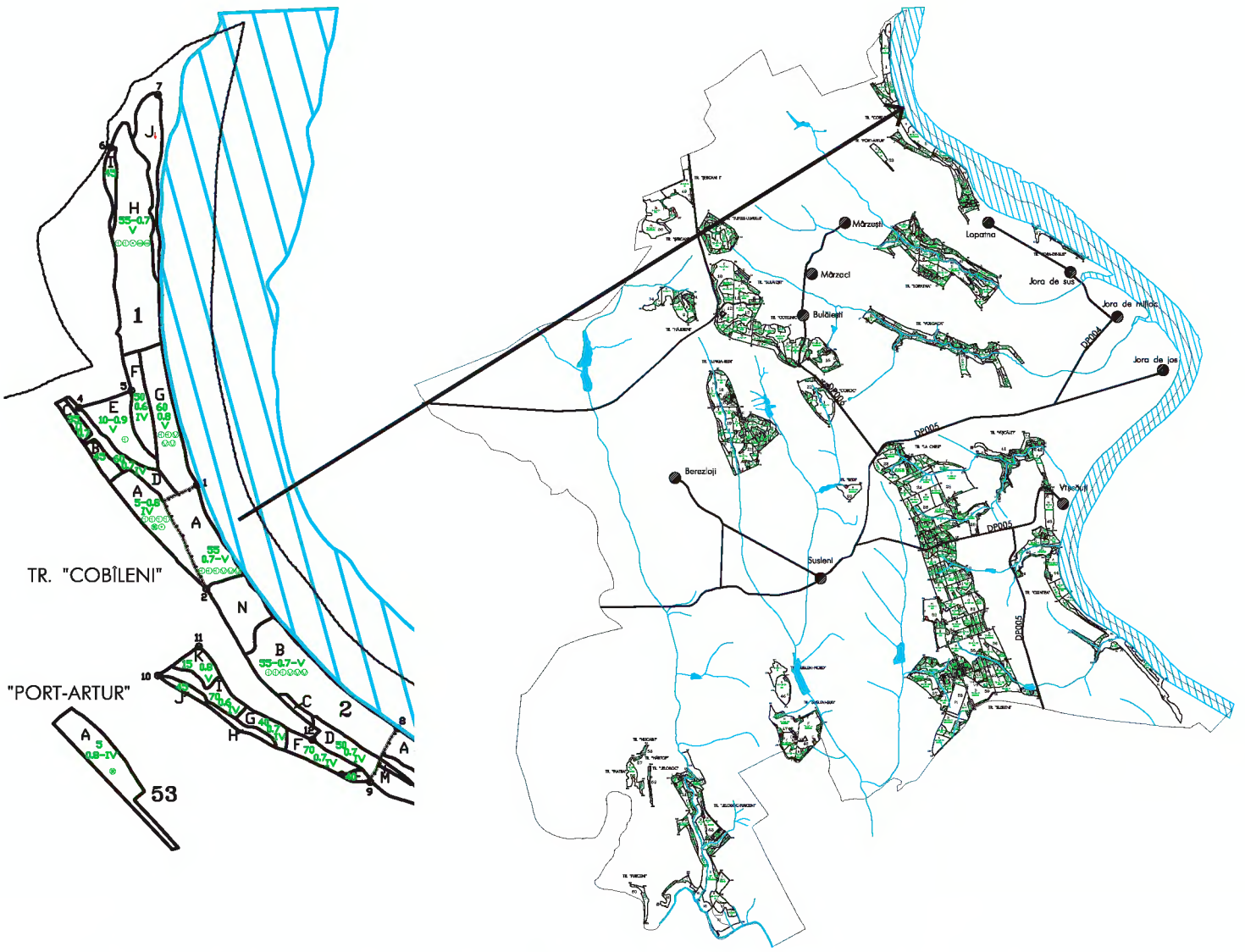

Figure 2. The Cobîleni Natural Forest Reserve in the Forest District Susleni.

Figure 3. The view of Cobîleni Natural Forest Reserve.

Figure 4. Wooded rocky substrates from the Natural Forest Reserve "Cobîleni".

Figure 5. The UV light trap used on collection of nocturnal geometrids species.

different methods: by sweeping with sweep net and during night with UV-light bucket trap with DRL 250W lamp bulbs. The biggest part of moths was caught using UV-light trap. The UV-light trap is composed from three panels surround the luminescent lamp of the trap. As a result of attracting insects by the UV-light, these are hitting on the panels, and after this, they fall in a funnel put under the lamp (fig. 5). The funnel is mounted on a glass jar with gasoline for to immobilize the insects and to kill the specimens after they land on the surface of light trap (Yi et al. 2012). Collecting of diurnal species was done with entomological net.

Sorting and preservation of samples. The collected entomological material in killing jar and paper triangles were taken to the laboratory of the Entomology Department of the Institute of Zoology of the Republic of Moldova for further sorting by groups. Paper triangles containing geometrids moths are stored in 21.59 cm x 27.94 cm zip lock plastic bag in the freezer. Arthropods other than Geometridae were emptied in jar with 70% ethanol or paper triangles and appropriate labels (dates and location).

The adults' genitalia structure was studied to confirm the taxonomic affiliation. For slide preparation of male and female genitalia, each specimen' abdomen was macerated in 10% NaOH during 24 hours at room temperature. The species identification was done using a microscope MBS-10.

All collected geometrid moths preserved in the freezer were after mounted, examined and identified. Species identification was based on collections from the Museum of Entomology of the Institute of Zoology of the Republic of Moldova and from the National Museum of Natural History of Moldova. Also, the modern taxonomic keys were used: Hausmann and Sihvonen (2019). Hausmann and Viidalepp (2012), Hausmann (2001, 2004), Xue and Zhu (1999), Savchuk (2013). Regarding taxonomy and nomenclature, we follow the checklist of geometrids of the former USSR (Viidalepp 1996), the catalogue of Russian Lepidoptera (Mironov et al. 2008), and the list of European Geometridae (Hausmann and Viidalepp 2012; Hausmann 2001, 2004; Mironov 2003; Rákosy et al. 2003; Müller et al. 2019; Nestorova 1998; Redondo et al. 2009; Skou 1986). We also consulted lepidopterological sites such as (Karsholt and van Nieukerken 2013; Lepiforum 2020; Jongo 2020; Mazzei et al. 2020; Khramov 2020).

Results

The environmental conditions of the Cobîleni Natural Forest Reserve such as humidity, temperature, altitude and vegetation determined a variation in the species diversity of Lepidoptera insects, including geometrid moths. As a result of investigations made during of the vegetation period of 2018, in this reserve, 370 specimens of Geometridae were collected The collected geometrid specimens belong to 55 species, taxonomically classified in 48 genera and 5 subfamilies (tab. 1). The systematic of collected species in this paper is done after Hausmann and Sihvonen (2019).

Table 1. The list of Geometridae species identified in Cobîleni Natural Forest Reserve

№	Species	Geographical distribution	Ecological forms	Trophic status
	Subfamily Ennominae			
1.	*Abraxas grossulariata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	A, D
2.	*Abraxas sylvata* (Scopoli, 1763)	Euro-Asian	Mesophilous	D
3.	*Lomaspilis marginata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	D
4.	*Heliomata glarearia* ([Denis and Schiffermüller], 1775)	Euro-Asian	Xero-thermophilous	P
5.	*Isturgia arenacearia* ([Denis and Schiffermüller], 1775)	Euro-Asian	Meso-xero-thermophilous	P
6.	*Neognopharmia stevenaria* (Boisduval, 1840)	Palaearctic	Mesophilous	A
7.	*Macaria notata* (Linnaeus, 1758)	Euro-Asian	Meso-xero-thermophilous	D
8.	*Chiasmia clathrata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	P
9.	*Plagodis dolabraria* (Linnaeus, 1767)	Euro-Asian	Mesophilous	D
10.	*Therapis flavicaria* ([Denis and Schiffermüller], 1775)	Ponto-Mediterranean	Meso-thermophilous	P
11.	*Pseudopanthera macularia* (Linnaeus, 1758)	Euro-Asian	Mesophilous	P
12.	*Apeira syringaria* (Linnaeus, 1758)	Euro-Asian	Meso-thermophilous	A
13.	*Ennomos quercinaria* (Hufnagel, 1767)	Euro-West Aasian	Meso-thermophilous	D
14.	*Ennomos erosaria* ([Denis and Schiffermüller],1775)	Euro-Asian	Mesophilous	D
15.	*Ourapteryx sambucaria* (Linnaeus, 1758)	Euro-Asian	Mesophilous	D
16.	*Selenia tetralunaria* (Hufnagel, 1767)	Euro-Asian	Mesophilous	D
17.	*Campaea margaritata* (Linnaeus, 1767)	Euro-Asian	Mesophilous	D
18.	*Hylaea fasciara* (Linnaeus, 1758)	Euro-Asian	Mesophilous	
19.	*Alsophila aescularia* (Denis and Schiffermüller, 1775)	Palaearctic	Mesophilous	D
20.	*Colotois pennaria* (Linnaeus, 1761)	Palaearctic	Mesophilous	D
21.	*Lomographa bimaculata* (Fabricius, 1775)	Euro-Asian	Meso-hygrophilous	D, A
22.	*Lomographa temerata* ([Denis and Schiffermüller], 1775)	Euro-Asian	Mesophilous	D, A
23.	*Siona lineata* (Scopoli, 1763)	Euro-Asian	Mesophilous	P
24.	*Angerona prunaria* (Linnaeus, 1758)	Euro-Asian	Mesophilous	A
25.	*Phigalia pilosaria* (Denis and Schiffermüller, 1775)	Palaearctic	Mesophilous	D, A
26.	*Ematurga atomaria* (Linnaeus, 1758)	Euro-Asian	Mesophilous	P
27.	*Erannis defoliaria* (Clerck, 1759)	Palaearctic	Mesophilous	D, A
28.	*Agriopis leucophaearia* (Denis and Schiffermüller, 1775)	West Palaearctic	Mesophilous	D
29.	*Agriopis marginaria* (Fabricius, 1776)	West Palaearctic	Mesophilous	D
30.	*Agriopis aurantiaria* (Hübner, 1799)	Palaearctic	Mesophilous	D, A
31.	*Odontopera bidentata* (Clerck, 1759)	Euro-Asian	Mesophilous	A, D, P
32.	*Parectropis similaria* (Hufnagel, 1767)	Palaearctic	Meso-thermophilous	D
33.	*Alcis repandata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	A, D, P
34.	*Cabera pusaria* (Linnaeus, 1758)	Euro-Asian	Mesophilous	D, A
35.	*Ascotis selenaria* ([Denis and Schiffermüller], 1775)	Euro-Asian	Mesophilous	P
36.	*Opisthograptis luteolata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	D
	Subfamily Orthostixinae			
37.	*Orthostixis cribraria* (Hübner, [1799])	Palaearctic	Mesophilous	P
	Subfamily Geometrinae			
38.	*Thetidia smaragdaria* (Fabricius, 1787)	Ponto-Mediterranean	Xero-thermophilous	P
	Subfamily Sterrhinae			
39.	*Idaea serpentata* (Hufnagel, 1767)	Euro-Asian	Meso-xero-thermophilous	P
40.	*Scopula tessellaria* (Boisduval, 1840)	Palaearctic	Mesophilous	P
41.	*Rhodostrophia vibicaria* (Clerck, 1759)	Euro-Asian	Xero-thermophilous	P
42.	*Timandra comae* A. Schmidt, 1931	Euro-Asian	Meso-thermophilous	P

Trophic status: A – Shrubs consumer, **D** – Deciduous consumer, **C** – Coniferous consumer, **P** – Herbs consumer.

Table 1. (continued)

№	Species	Geographical distribution	Ecological forms	Trophic status
43.	*Cyclophora annularia* (Fabricius, 1775)	Euro-Asian	Meso-thermophilous	D
44.	*Cyclophora albiocellaria* (Hübner,1789)	Ponto-Mediterranean	Meso-hygrophilous	D
45.	*Cyclophora porata* (Linnaeus, 1767)	European	Meso-thermophilous	D
46.	*Cyclophora linearia* (Hübner, 1799)	Euro-Asian	Mesophilous	D
47.	*Lythria purpuraria* (Linnaeus, 1758)	West Asian-Mediterranean	Meso-xero-thermophilous	P
	Subfamily Larentiinae			
48.	*Asthena anseraria* (Herrich-Schäffer, 1855)	Palaearctic	Mesophilous	A
49.	*Hydrelia flammeolaria* (Hufnagel, 1767)	Euro-Asian	Meso-hygrophilous	A, D
50.	*Camptogramma bilineata* (Linnaeus, 1758)	Euro-Asian	Meso-hygrophilous	P
51.	*Euphyia biangulata* (Haworth, 1809)	Palaearctic	Mesophilous	P
52.	*Pelurga comitata* (Linnaeus, 1758)	Euro-Asian	Mesophilous	P
53.	*Electrophaes corylata* (Thunberg, 1792)	Euro-Asian	Mesophilous	D
54.	*Melanthia procellata* ([Denis and Schiffermüller],1775)	Euro-Asian	Mesophilous	A
55.	*Operophtera brumata* (Linnaeus, 1758)	Palaearctic	Mesophilous	D, A

Trophic status: A – Shrubs consumer, **D** – Deciduous consumer, **C** – Coniferous consumer, **P** – Herbs consumer.

According to the data form the table 1, the subfamily with greatest species richness from this reserve proved to be Ennominae with 36 species (65.5 %), followed by Sterrhinae with nine species (16.4 %) and Larentiinae with eight (14.5 %). The last two subfamilies – Orthostixinae and Geometrinae with only one species each (1.8 % each). Such a big species number in Ennominae subfamily is due to the fact that this subfamily is the largest of the Geometridae family, with more than 9,700 described species of 1,100 genera all over the world, and in Europe – 202 species (Müller et al. 2019).

Out of 48 genera, the most diverse genera were *Cyclophora* with four species, *Agriopis* – 3, *Abraxas*, *Ennomos* and *Lomographa* with two species each.

A majority of Geometridae species (35) collected in the Cobîleni Natural Forest Reserve have an Euro-Asian distribution that consist – 63.6 %. Also, we have 12 Palaearctic species which comprise 21.8 %, and three species are Ponto-Mediterranean (5.45 %). Finally, *Ennomos quercinaria* is an Euro-West Asian element, *C. porata* is an European element, *L. purpuraria* has West Asian-Mediterranean distribution, but *A. leucophaearia* and *A. marginaria* are West Palaearctic species (fig. 6).

The geometrids collected in the Cobîleni Natural Forest Reserve can be attributed to the following five ecotypes: meso-hygrophilous, mesophilous, meso-xero-thermophilous, meso-thermophilous and xero-thermophilous species.

From 55 collected species in the Cobîleni Natural Forest Reserve, 37 are mesophilous elements (67.2 %) and 4 species (7.3 %) are meso-hygrophilous inhabiting mesophilous grasslands, gardens, scrubland and mixed forests, forest fringe, brushwood of shrubs, river plains. Other seven species (12.7 %) are meso-thermophilous elements, four meso-xero-thermophilous species (7.3%) and three xero-thermophilous (5.5 %). The xero-thermophilous geometrid species inhabit dry,

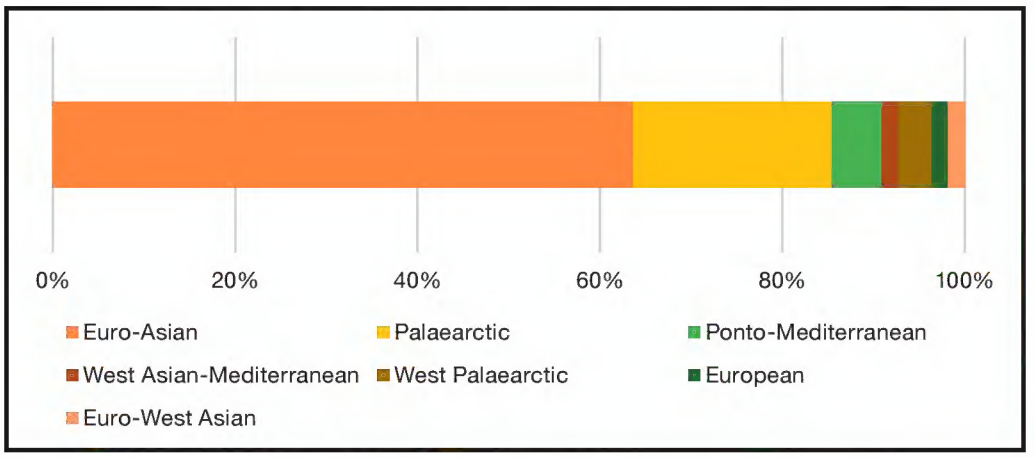

Figure 6. Geographical distribution of Geometridae species identified in the Cobîleni Natural Forest Reserve.

and open grassland, in this reserve, characteristic of steppes or are found both on dry southern slopes, and on more damp meadow-vegetation, but mainly in open, sunny places (figs 3, 7).

Regarding the larvae trophic spectrum of these identified 55 geometrid species from the Cobîleni" Natural Forest Reserve, 58% are forest tree defoliators. From 29 tree defoliator species collected in the reserve, 20 species, which consist approximatively 36.4% from all collected species, feed mainly on deciduous trees. The geometrid caterpillars of nine species (16.4 %) are shrubs and trees defoliators: *L. bimaculata*, *A. grossulariata*, *L. temerata*, *Ph. pilosaria*, *E. defoliaria*, *A. aurantiaria*, *C. pusaria*, *H. flammeolaria* and *O. brumata* (tab. 1, fig. 8). In addition, during the study in the Cobîleni Natural Forest Reserve, butterfly specimens of five species which larvae are just shrubs consumer were collected. Thus, the inchworms of *A. prunaria* feed on *Betula*, *Alnus*, *Salix*, *Ribes*, *Vaccinium* etc., of *A. syringaria* on *Syringa* and *Lonicera*;

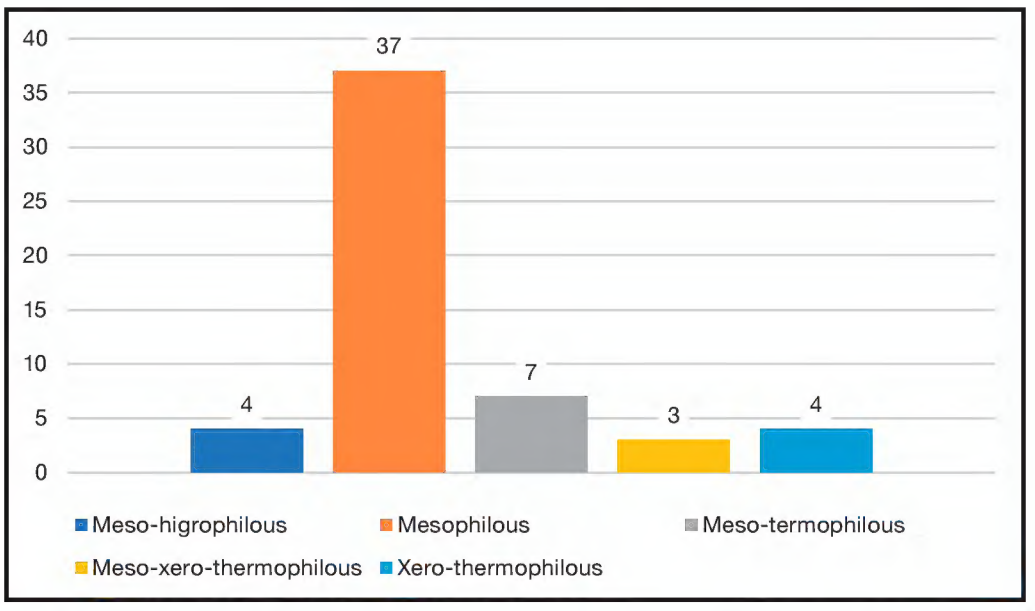

Figure 7. Ecological status of geometrid caterpillar species identified in the "Cobîleni" Natural Forest Reserve.

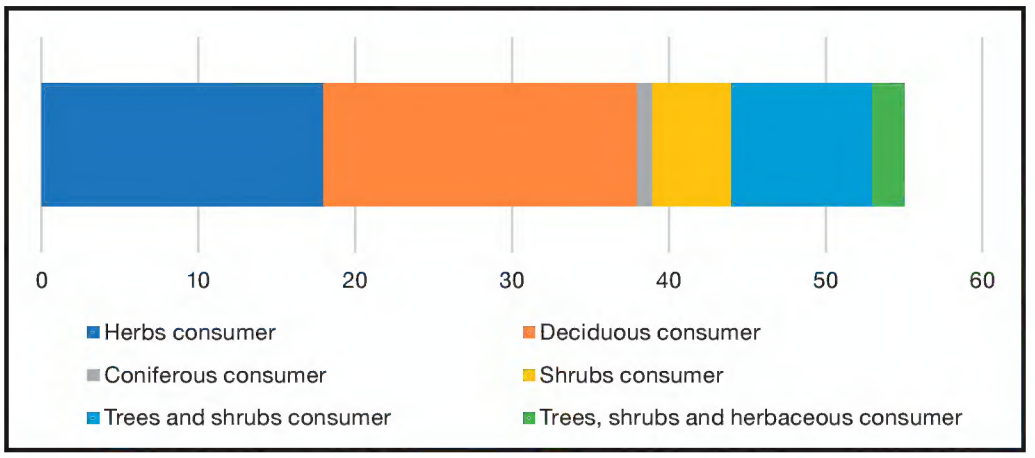

Figure 8. The trophic spectrum of geometrid caterpillars species identified in the Cobîleni Natural Forest Reserve.

of *N. stevenaria,* on *Crataegus azarolus*, *Prunus dulcis* and *P. spinosa*. The larvae of *A. anseraria* feed on *Cornus sanguinea* and those of *M. procellata,* on *Clematis sp.*

In the sub parcels where the predominant species is the Scots pine (*Pinus sylvestris*), we collected adults of *H. fasciaria* whose inchworms are coniferous consumer.

The plant hosts of the larvae of twenty species (37%) are flowering plants and spontaneous herbs, collected in the reserve or from the adjacent biotypes. The caterpillars of *O. bidentata* and *A. repandata* feed on deciduous trees, shrubs and spontaneous herbs (tab. 1).

In addition to common species undoubtedly, the most important insect species from the whole territory of the reserve are those ones having the statue as new for the fauna of the Republic of Moldova or / and are considered threatened in neighbour countries and Europe. After studying the literature regarding the geometrid diversity of the Republic of Moldova (Hormuzaki 1894; Miller and Zubowski 1908–1913; Zubowsky and Ruscinski 1938; Miller et al. 1930; Miller et al. 1932; Apostolov 1970; Derjanschi et al. 2016; Timuș et al. 2017) the Clay Triple-lines - *C. linearia* is a new species record for Republic of Moldova.

Discussions

With the 55 Geoemetridae moth species recorded during this research, which represents more than 20% of the country's Geometridae fauna, the area of the Cobîleni Natural Forest Reserve represent a particular importance in terms of biodiversity.

From the collected species, several are dangerous forest and agriculture pests. Therefore, *L. purpuraria* and *I. arenacearia* are pest of alfalfa (Nestorova 1998) and in the same time are rare in Romania (Rákosy et al. 2003), Lithuania (Inokaitis and Paulavičiūtė 2020), Germany etc. The most dangerous Geometer pests in the woods of the Republic of Moldova are *O. brumata* (Linnaeus, 1758), *A. aurantiaria* (Hübner, 1799), *E. defoliaria* (Clerck, 1759), *A. leucophaearia* (Denis and Schiffermüller, 1775),

A. marginaria (Fabricius, 1776), *Ph. pilosaria* (Denis and Schiffermüller, 1775), *A. aescularia* (Denis and Schiffermüller, 1775) and *C. pennaria* (Linnaeus, 1761). Their caterpillars are polyphagous, forming an important link in the spring forest defoliators group (Patočka et al., 1999, Bulgari et al., 2016, Derjanschi et al., 2012, Rodideal et al., 2015). In outbreaks with high numerical density, the inchworms can produce partial or total tree defoliations, especially on *Quercus sp.*, also on *Tilia sp.*, *Carpinus sp.*, *Corylus sp.*, *Cornus sp.* and *Prunus sp.* The adults of most important Geometridae pests occur in the cold part of the year (late autumn or early spring) and their brachypterous females are unable to fly (Wahlberg et al. 2010).

Regarding the new species for the fauna of the Republic of Moldova – the *C. linearia* has a Palaearctic distribution area, being a common species in Europe in the beech forests (primary host-plant), deciduous and mixed forests, parks, scrub (where bilberry, oak and willow are second host-plats) and of course in the gardens. In conditions of Europe, the Clay Triple-lines hibernates as pupae under the fallen leaves, having two generations per year. The first generation can be seen from third decade of April to June and the second one from July to September. Triple-lines develops in June–July and August until early autumn being easily observed on low branches of host plants.

If we take into consideration the conservation status, we should mention that the rarity status of geometrids on the territory of the Republic of Moldova is not established, due to the incomplete study of this butterfly group. We should mentioned that Swallow-tailed Moth, *O. sambucaria,* one of largest and striking Geometrids in the Republic of Moldova, in Romania, it is a Critically Endangered species. Species *A. sylvata* (Scopoli, 1763), *O. cribraria* (Hübner, [1799]) and *S. tessellaria* (Boisduval, 1840) are vulnerable (Rákosy et al. 2003) and more than twenty are Near Threatened in Romania and other countries of Europe (Rákosy et al. 2003; Inokaitis and Paulavičiūtė 2020 etc.).

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References

Apostolov L (1970) Dendrofil'naya entomofauna Gerbovetskogo lesa. Gerbovetskiy les. Kishinev. 213–223. [in Russian]

Begu Ad, Begu A (2005) Rezerve de extindere a rezervației naturale „Cobîleni". Buletin Științific. Revistă de Etnografie, Științele Naturii și Muzeologie. Vol. 2 (15). Serie nouă. Fascicula Științele Naturii. Chișinău: 22–24. [in Romanian]

Bulgari V, Erșova E, Vasilciuc S, Stahi N (2016) Report on development and spread of pests and diseases in the forests managed by the Agency "Moldsilva" in 2015, including forecast for the 2016. Chişinău, 91 pp.

Derjanschi V, Baban E, Calestru L, Stahi N, Ţugulea C (2016) Catalogue of the N. Zubowsky entomological collection. Chişinău "Bons Offices" 296 pp.

Derjanschi V, Baban E, Timuş A, Andreev A, Gaibu Z, Stahi N, Calestru L, Galupa D, Uspenskaia I (2012) Atlas of invertebrates (included in the Cadastre of Animal kingdom of the Republic of Moldova). Academy of Science of the Republic of Moldova, Institute of Zoology 116 pp.

FAO (2010) Global Forest Resources Assessment 2010. Main Report. Food and Agriculture Oranization of the United Nations, Rome. (http://www.fao.org/3/i1757e/i1757e.pdf). Electronic version accessed 05.03.2020.

FAO (2020) Global Forest Resources Assessment 2020 Key findings. Rome. (https://doi.org/10.4060/ca8753en). Electronic version accessed 17.05.2020.

Hausmann A (2001) The Geometrid Moths of Europe. Introduction, Archiearinae, Orthostixinae, Desmobathrinae, Alsophilinae, Geometrinae. Stenstrup, Apollo Books, 1: 282 pp.

Hausmann A (2004) Sterrhinae. In: Hausmann A (Ed.) The Geometrid Moths of Europe. Stenstrup, Apollo Books, 2: 600 pp.

Hausmann A, Sihvonen P (2019) Revised, annotated systematic checlist of the Geometridae of Europe and adjacent areas. In: Müller B, Erlacher S, Hausmann A, Rajaei H, Sihvonen P, Skou P (Eds) The Geometrid Moths of Europe vol 6, Brill, Leiden - Boston, 906 pp.

Hausmann A, Viidalepp J (2012) The Geometrid Moths of Europe. Larentiinae. Stenstrup, Apollo Books, 3: 743 p.

Hormuzaki C (1894) Untersuchungen uber die Lepidopterefauna der Bukowina. Czernowitz 183 pp. [in German]

Inokaitis V, Paulavičiūtė B (2020) New data on 38 rare for the Lithuanian fauna Lepidoptera species recorded in 2019. Bulletin of the Lithuanian Entomological Society 31: 42–47.

Jongo Ch (2020) Lepidoptera Mundi (formerly European Butterflies and Moths) (https://lepidoptera.eu/) Electronic version accessed 15.05.2020.

Karsholt O, van Nieukerken EJ (2013) Fauna Europaea: Lepidoptera, Moths. Fauna Europaea version 2017.06, (https://faunaeur.org) Electronic version accessed 10.05.2020.

Khramov P (2020) Insects (Insecta) of the World (http://insecta.pro). Electronic version accessed 15.05.2020.

Külvik M (Compiler) (1993) Estonia. Environmental Status Report 1993. IUCN EEP. Environmental Status Reports: 5: 178 pp.

Mazzei P, Morel D, Panfili R (2020) Moths and Butterflies of Europe and North Africa (https://www.leps.it) Electronic version accessed 20.02.2020.

Miller E, Zubowski N (1908–1913) Materialien zur Kenntnis der entomologischen Fauna Bessarabiens. Macrolepidoptera. Travaux de la Société des Naturalistes et des Amateurs

des sciences naturelles de Bessarabia, Kischineff. Teil I. 1908: 410–425; Teil II. 1910: 93–96; Teil III. 1913: 261–262. [in German]

Miller E, Zubowski N, Ruschtschinsky A (1930) Materiale pentru fauna entomologică din Basarabia. Macrolepidoptera. Buletinul Muzeului Național de Istorie Naturală, Chişinău 3–4: 1–34. [in Romanian]

Miller E, Zubowski N, Ruschtschinsky A (1932) Materialien zur Kenntnis der entomologischen Fauna Bessarabiens. Macrolepidoptera Nachtrag IV. Buletinul Muzeului Național de Istorie Naturală, Chişinău 4: 25–38. [in German]

Mironov V (2003) Larentiinae II (Perizomini and Eupitheciini). Hausmann A (Eds) The Geometrid Moths of Europe, Stenstrup (Apollo Books), 4: 463 pp.

Mironov V, Belyaev E, Vasilenko S (2008) Geometridae. In: Sinev SY (Eds) Catalogue of Lepidoptera of Russia. St. Petersburg – Moscow (Fellow. Scien. KMC editions), 190–226 p. [In Russian].

Müller B, Erlacher S, Hausmann A, Rajaei, H, Sihvonen P, Skou P (2019) Geometrid Moths of Europe, vol. 6, Ennominae II. Leiden: Brill. 906 pp.

Nestorova E (1998) Lepidoptera, Geometridae. Catalogus faunae Bulgaricae 2. Moscow [in Bulgarian].

Patočka J, Krištín A, Kulfan J, Zach P (1999) Die Eichenschädlinge und ihre Feinde. Zvolen: Institut für Waldökologie der SAW, 396 pp. [in German]

Postolache Gh, Lazu Ş (2018) Ariile naturale protejate din Moldova. Rezervații Silvice 3: 212 pp. [in Romanian]

Rákosy L, Goia M, Kovács Z (2003) Catalogul lepidopterelor României = Verzeichnis der Schmetterlinge Rumäniens. Societatea Lepidopterologică Romană, Cluj-Napoca, 447 pp. [in Romanian and German]

Redondo V, Gaston J, Gimeno R (2009) In: Corley M, Skou P (Eds) Geometridae Ibericae . Apollo Books, 224 pp. [in Spanish]

Rodideal I, Ersova E, Bulgari V, Vasilciuc S, Stahi N, Scutelnic A (2015) Report on development and spread of pests and diseases in the forests managed by the Agency "Moldsilva" in 2014, including forecast for the 2015. Chişinău, 107 pp.

Savchuk V (2013) Atlas of moths and caterpillars of Crimea. Simferopol. Business Inform, 296 pp. [in Russian].

Skou P (1986) The Geometrid Moths of North Europe. Entomonograph 6, Brill. Leiden. 348 pp.

Stanciu E (2013) Ghid pentru managementul operațional al ariilor protejate din Republica Moldova, UNDP-GEF/MSP Rep. Moldova, Fortificarea capacităților instituționale și a reprezentativității sistemului de arii protejate din Rep. Moldova, Min. Mediului – Chişinău: UNDP Moldova. [in Romanian]

Stanciu E (2013) Guide for Monitoring Management Efficiency and Implementing the Reporting System for Protected Areas in the Republic of Moldova, 73 pp.

Stork N, Adis J, Didham R (1997) Canopy arthropods. Chapman and Hall, London, 237–264.

Timuş A, Croitoru N, Mihailov I (2017) Cadre didactice din domeniul entomologiei agricole. Istorie şi contemporanietate. Chişinău. S.n. Tipogr. "Print-Caro", 247–275. [in Romanian]

Viidalepp J (1996) Checklist of the Geometridae (Lepidoptera) of the former USSR. Stenstrup (Apollo Books) 131 pp.

Wahlberg N, Snäll N, Viidalepp J, Ruohomäki K, Tammaru T (2010) The evolution of female flightlessness among Ennominae of the Holarctic forest zone (Lepidoptera, Geometridae). Molecular Phylogenetics and Evolution 55(3): 929–938.

Xue D, Zhu H (1999) Lepidoptera, Geometridae, Larentiinae. Fauna Sinica, Beijing (Science Press), 1090 pp.

Yi Z, Jinchao F, Dayuan X, Weiguo S, Axmacher J (2012) A comparison of terrestrial arthropod sampling methods. Journal of Resources and Ecology 3(2): 174–182.

Zubowsky N, Ruscinski A (1938) Materiaien zur Kenntnis der entomologischen Fauna Bessarabiens. Macrolepidoptera. Nachtrag V. Buletinul Muzeului Regional al Basarabiei, Chişinău. 8: 23–32. [in German]

*** Lepiforum: Bestimmung von Schmetterlingen (Lepidoptera) und ihren Präimaginalstadien (http://lepiforum.de) Electronic version accessed 20.05.2020. [in German]

*** MoldSilva.gov.md: Forest Resources http://www.moldsilva.gov.md/pageview.php?l=en&idc= 180&t=/National-Forest-Land/Forest-Resources/Forest-Resources/. Electronic version accessed 13.05.2020.